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Use of predictive text in text messaging over the course of a year and its relationship with spelling, orthographic processing and grammar

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An investigation into the impact of predictive text use upon the literacy skills of primary school, secondary school and university cohorts was conducted over the course of a year. No differences in use of text abbreviations (‘textisms’) were found between predictive text users and nonusers. However, secondary school children who used predictive text made more genuine spelling errors than nonusers. Predictive text was related to use of some specific grammatical violations in school-age children’s text messages but was not related overall to the tendency to make grammatical errors when texting. University students, however, made significantly fewer grammatical errors in their text messages when they used predictive text. Over the course of a year, predictive text use was variable for all age groups. Consistency of predictive text use was unrelated to grammatical understanding, spelling or orthographic processing for primary and secondary school cohorts. Predictive text use was negatively related to morphological awareness for adult participants.

Within the last decade, research attention has begun to focus on the impact of mobile phone text messaging (also known as the short message service or SMS) on written language skills. Much of this research has primarily focused on traditional textisms, which are the shortened word forms used when writing in the context of an SMS message, for example, txt (text), c (see) and innit (isn’t it) (De Jonge & Kemp, 2012; Drouin, 2011). This shorthand has been adopted by users as a method of convenience to save on both space (and, therefore, the cost of the message) and time (Tayebinik & Puteh, 2012). Textisms are also used to show social belonging, where individuals from certain cliques will use specific forms of shortenings to strengthen social bonds, and for this reason, textism usage has spread from mobile phones to other forms of digital communication, such as instant messaging (Lewis & Fabos, 2005).

The potentially detrimental impact of texting on spelling ability has been debated in popular media (e.g., Crystal, 2008; Humphrys, 2007), and such claims have stimulated research into this area. A large proportion of this research has been conducted with child cohorts and has generally found textism usage to impact positively on language-related skills (Wood, Jackson et al., 2011; Wood, Meachem et al., 2011). For example, researchers have found that the degree of textism use in child cohorts was positively related to verbal reasoning skills (Plester, Wood, & Bell, 2008), word reading, vocabulary and phonological awareness (Plester, Wood, & Joshi, 2009). Better readers are also most likely to be the children who send the most text messages and use the most textisms within these messages (Coe & Oakhill, 2011; Durkin, Conti-Ramsden, & Walker, 2011). This positive relationship was thought to arise from several factors, including increased 'exposure to print', but research data have not supported this suggestion (Wood, Jackson et al., 2011). However, for children who do not read or write much, texting provides an alternative format where they do not feel pressurised by a fear of failure in terms of writing abilities (Crystal, 2008) and can feel free to express themselves (Thurlow, 2003). For example, Tagg (2013) examined a corpus of almost 11,000 text messages and found evidence of not only speechlike expression in texting but also creative practices including idiom manipulation, punning, orthographic play and word play. The most likely explanation for the positive associations between language skills and textism use in children aged 8–12 years stems from the contribution that textism use appears to make to phonological skills. That is, many of the most frequently used forms of textism rely upon phonological decoding, such as nite for night or u for you. In order for children to both write and understand abbreviated messages, they must firstly have a good knowledge of phonological and alphabetic ('phonic') principles. Thus, this suggests that textism use could actually reinforce children's phonological representations and understanding of letter-sound correspondences. The results of a longitudinal study of children's traditional textism use by Wood, Meachem et al. (2011) support this interpretation. The findings from research conducted with adolescent and adult populations are less clear. A study that asked participants to translate formal English sentences into text messages found that the degree of textism use was negatively related to reading, nonword reading, spelling and morphological awareness (De Jonge & Kemp, 2012). However, other adult research has found evidence of positive relationships between other measures: selfreported texting frequency, and spelling and reading ability (Drouin, 2011). Frequency of texting and use of textisms, however, are not necessarily comparable constructs, as some individuals may text frequently with hardly any textism use and others may text frequently with greater textism usage. There are further reasons for such variability within adult samples. Firstly, adults are more influenced by exposure to misspellings than children (Dixon & Kaminska, 2007; Katz & Frost, 2001); thus, adults may have greater variation in results dependent upon the specific type of textisms they use. For example, adults who use emoticons such as ☺ or initialisms such as lol for laugh out loud are still using textisms but are not being exposed to nontraditional spellings. Thus, it is important to consider the types of textism used (see section on Test Battery). Secondly, differences in data collection methods can lead to differences in textism densities, as naturalistic text messages have been found to have significantly lower textism densities than experimentally produced messages (Grace, Kemp, Martin, & Parrila, 2013). Naturalistic messages are therefore more likely to provide data that reflect normal texting behaviours than experimentally elicited or translated messages. Differences in patterns of association within the different age groups could be due to the lives; for example, children (including some as young as 5 years old) are reported to regularly access social media via the Internet (Marsh, 2012), and some now receive mobile phones at this age (Ofcom, 2014).

In terms of technological advancement, one aspect of phone use that has received relatively little investigation is that of predictive texting. Predictive texting (called T9 on some phones) is where an individual uses fewer key presses on a phone number pad than the number of letters in a word to reach the desired word. In previous years, users with an alphanumeric keypad only had to press the numbers that relate to each letter in the word once, as opposed to multipress texting, where users have to press a number several times to reach the desired letter. For instance, if someone wanted to write the word ‘home’, a multipress user would have to press the ‘4’ key twice to obtain the letter ‘h’, and a total of seven presses would be needed to complete the word. In comparison, a predictive texter would only have to input ‘4663’ to obtain the entire word, a total of four presses. Today, users are more likely to have a QWERTY keypad. Predictive texting can also occur on this type of phone, where the user inputs the first few letters of a word and the phone predicts and fills in the last letters. For both types of predictive messaging, the phone software autocorrects some punctuation for the user, such as inputting capitalisation and apostrophes, for example, changing im to I’m. On some handsets, the software on the phone ‘learns’ frequently used words and uses these as predictive text suggestions, irrespective of the spelling of those words. On older phones, it is also possible to input words and text abbreviations into the phone’s dictionary. It is therefore not to be assumed that the use of predictive text will necessarily result in the user being prompted to use correctly spelled words or ‘real’ words (as opposed to textisms). On most newer devices (including iPhones and Blackberries), users can also programme in their own words and turn off this predictive feature if they choose. It is interesting to note that Conti-Ramsden et al. (2011), who worked with adolescents with poor language abilities, found that these adolescents tended not to use autocorrection features even when they were readily available on their phones. Conti-Ramsden and colleagues suggest that poor spellers avoid autocorrection because their incorrect attempts such as wiered (for weird) can be autocorrected to unintended words such as wired. This kind of evidence serves as a reminder that not all individuals find predictive text or autocorrect functions helpful and may actively seek to disable them where this is an option. Across English-speaking countries, there are still cases of phones with alphanumeric keyboards with T9 text being used much more frequently than so-called smartphones or more advanced phones with a touchscreen QWERTY keyboard and the capacity to access the Internet and run applications (Pew Research Centre, 2014). Thus, the analysis of both T9 and autocorrect features remains a worthy area of research even today. It is also prudent to note that younger children often receive a first phone, which is not a smartphone, and thus are more likely to be exposed to traditional T9 predictive text (Ofcom, 2014). There is also a rapidly changing digital market, and for this reason, it is important to look at the impact of 'digital shifters', those who change their technology frequently, as multiple changes in technology may lead to multiple changes in writing style and thus impact upon literacy abilities. This may be especially a problem for adults, who struggle more than children when code-switching between different languages (Hernandez & Kohnert, 1999). The use of predictive text can affect the way that messages are written. In a study with alphanumeric keyboard phones, Kemp and Bushnell (2011) found that predictive texters were faster at writing text messages than their multipress counterparts. Research has also shown that nonpredictive QWERTY keyboard users are faster at writing messages than predictive alphanumeric pad users (Cerney, Mila, & Hill, 2004). This is likely to be due to predictive texting requiring a higher cognitive load, as alphanumeric users have to consciously consider which number corresponds to the correct letter, as opposed to QWERTY users who have a one-to-one mapping on their keypad. Kemp and Bushnell (2011) found that, in the context of an experimental task, text entry method was not related to spelling or reading scores. However, the media claim that predictive text use may impact on the development of written language skills has not been examined longitudinally or in the context of individuals' actual sent text messages.

More recently, media attention has turned towards young people's grammatical abilities, and in England, grammar lessons have been (re)introduced into primary education to improve use of punctuation, contractions, homophones and apostrophes (Barrett, 2012). Despite some journalists' claims that bad grammar is caused by texting (e.g., Clark, 2012), the few empirical studies on this question have found that traditional textism use had no relationship with grammatical ability in primary school children (Authors). However, there was some evidence of negative associations in students at secondary school (Cingel & Sundar, 2012) and university (Authors). With prior research finding conflicting associations between literacy and textism use when looking at concurrent data only (Verheijen, 2013), we present longitudinal data, which will help to resolve some of the questions raised by the growing body of cross-sectional research findings. No studies to date have explored the potential impact of predictive texting on grammatical abilities in any age group. We argue that use of predictive text is an important factor to consider when addressing questions on the possible impact of technology on written language skills. When using predictive text, individuals may be exposed to a greater amount of correct punctuation, capitalisation and spelling than they would be when not using predictive text, as errors in these areas are often corrected for the user by the predictive text function. Because previous research has shown that exposure to correct spellings improves spelling performance in adults (Dixon & Kaminska, 2007), it could follow that predictive messaging would have a positive impact on the literacy-related skills of adult texters. Drouin and Driver (2012) found that adults who always used predictive text used similar proportions of textisms in their messages as those who never used it but the use of textisms related differentially to literacy skills between users and nonusers. For those who never used predictive messaging, omitted apostrophes were negatively correlated with measures of reading, and letter/number homophones were negatively correlated with vocabulary. Positive correlations were observed between spelling ability and some phonetic forms of text abbreviation amongst users of predictive text. Thus, it seems that for adults, predictive messaging may be beneficial. However, no such studies have yet examined the potential impact of predictive messaging on younger cohorts. Using predictive text does not ensure that the user will write in grammatically correct sentences, as it is still possible to omit words or use unconventional forms of punctuation, such as using smiley faces for full stops. This means that predictive texting could influence knowledge of various grammatical properties in different ways.

In this paper, we analysed data from a longitudinal study that was conducted with primary school, secondary school and university aged cohorts (Authors). We considered whether our participants' use of predictive text was related to their tendency to use textisms in their text messages, to violate conventional grammar in their text messages (in terms of missing punctuation and ungrammatical word use), and the growth over time in their performance on measures of spelling, orthographic processing and grammatical understanding. To do this, we compared the participants who reported using the predictive text function consistently with those who never used it and those who changed in their use of this function over time. As previous research has found different patterns of association for adults and children with respect to their textism use and its relationship with literacy skills, primary school students, secondary school students and university students are examined separately.

We anticipate the following:

1. Those individuals who use predictive text will be less likely to use textisms in their messages than those who use predictive text less often.

2. Those individuals who use predictive text will tend towards poorer performance on measures of grammatical understanding (i.e., the Test for Reception of Grammar and a pseudoword orthographic choice test) than those who use predictive text less often.

3. Predictive text use will be associated with spelling performance in a sample of children and young adults.

Materials and method

Participants

The sample included primary school children (N= 83, men = 38, women = 45) aged between 8.6 and 10.9 years, and secondary school children (N= 77, men = 48, women = 29) aged between 11 and 15.9 years. The university group consisted of undergraduate students at a university in the United Kingdom (N= 48, men = 11, women = 37) aged between 18 and 30 years, who gained course credit for participation. All participants were recruited from the West Midlands of the United Kingdom. These 208 participants took part at Time 1 (T1) in 2011, and 195 participants continued on to take part at Time 2 (T2, 76 primary school children, 67 secondary school children and 47 undergraduates), 12 months later, in 2012. As a result of the particular attrition in the undergraduate group, we checked to see if there were any significant differences between those who completed the study and those who only completed the T1 measures. No significant differences were found.

Test battery

Test for Reception of Grammar II (TROG II; Bishop, 2003). This measure was included as a standardised assessment of the participants' understanding of spoken grammar and required participants to pick a picture (from a choice of four) that represented a sentence that the researcher said aloud. The sample alpha for this measure was 0.922.

Pseudoword orthographic choice task (see Wood et al., 2014, for a detailed description). This task assessed participants' ability to understand grammatical spelling rules. Participants were given sentences with an option of two phonologically plausible pseudowords and had to choose the correct version based on the target's grammatical status. For example, the spelling prees is correct when this pseudoword is presented as a plural (e.g., There were many prees/preeze), but preeze is correct if it is presented as a singular noun (e.g., We need at least one prees/preeze). The sample alpha for this measure was 0.882.

Wordchains (Guron, 1999) with articulatory suppression. The Wordchains task was used as a measure of orthographic processing ability. The standardised task required participants to look at a series of letter strings, which comprised three or four words presented together without any spaces between the words. Participants were asked to mark the boundaries between the words with a pencil stroke as quickly as possible. To ensure that this was purely a measure of orthographic processing, the additional constraint of articulatory suppression was added to the task. That is, participants were also required to say the syllable 'la' repeatedly during the activity in order to minimise phonological processing. The sample alpha was 0.970.

*Wide Range Achievement Test IV (*Wilkinson & Robertson, 2006) – spelling subtest. This task is a standardised assessment of spelling ability suitable for both children and adults, and was administered in groups. The sample alpha was 0.939.

Grammatical violations in text messages. Participants were asked to copy all the messages that they had sent within the last 2 days prior to testing, exactly as they had written them. If they had not written any messages in the last 2 days, they were asked to transcribe at least the last five they had sent, regardless of how long ago. Primary school children were asked to complete this task at home and to have a parent to sign at the bottom to confirm that the messages were copied correctly. Secondary school children transcribed their own messages, which were verified by a member of the research team. Finally, adult participants were assumed to correctly transcribe their messages by themselves, and no checks were run on these messages. The text messages were coded for the number and nature of grammatical violations that were observed. For example, im would be coded as both missing contractive apostrophe and i for I. There were six broad categories of grammatical violation:

• unconventional orthographic form (e.g., using symbols such as emoticons in place of traditional punctuation such as question marks)

• punctuation and capitalisation errors (omission and incorrect use, e.g., im for I'm or want's for wants)

• missing words (e.g., u comin? for are u comin?)

• grammatical homonyms (e.g., using there/their/they're incorrectly)

• ungrammatical word forms (e.g., they is for they are)

• word reduction (e.g., hafta for have to)

The number of times these types of error occurred was divided by the total number of words used in all the messages sampled, to provide a measure of use of grammatical violation relative to message length. The authors consider that these grammatical violations are a separate form of textism from those textisms listed in Thurlow's (2003) traditional coding scheme and are henceforth referred to as grammatical textisms.

Traditional textism coding (Thurlow, 2003). Participants' transcribed messages were also coded for the use of other types of textisms (beyond the types that violated grammar as listed previously), to be consistent with other studies already published in this area (e.g., Plester et al., 2009; Wood, Jackson, et al., 2011; Wood, Meachem, et al., 2011). As for the grammatical textisms, the total number of other textisms used was divided by the total number of words in the messages to provide a measure of textism use relative to message length. These textisms were coded as follows, in line with previous research:

• shortenings (removing word endings, e.g., bro and mon for brother and Monday)

• contractions (removing letters from the middle of words, usually vowels, e.g., ltr and msg for later and message)

• clippings (removing letters from word endings, e.g., hav and goin for have and going)

• acronyms/initialisms (using the first letter from every word in a phrase, to make a short version, e.g., lol and BBC for laugh out loud and British Broadcasting Corporation)

• letter number homophones (using the sound of a letter or number to spell part or all of a word, e.g., l8r and 2morrow for later and tomorrow)

• nonconventional spellings (spelling phonetically, e.g., fone and luv for phone and love)

• accent stylisation (writing to reflect spoken language, e.g., innit and gonna for isn't it and going to).

• misspellings (misspelling words nonphonetically, e.g., comming and rember for coming and remember)

‘Misspellings’ were coded as a separate category on their own for the current study. This was because we are fairly confident that these are genuine errors rather than deliberate textisms and thus do not represent an intentional spelling alteration, as traditional textisms do.

Self-report questionnaire. All participants were given a questionnaire at both time points asking if they used predictive messaging ‘always’, ‘sometimes’ or ‘never’. Participants were also asked to report the type of keypad their current phone had, from a choice of ‘alphanumeric’, ‘QWERTY’ or ‘alphabetic’. (Alphabetic keypads are similar to QWERTY in the fact that they have a single button to represent each letter of the alphabet, but they are laid out in alphabetical order.) These concepts were explained verbally to the primary school children to ensure understanding.

General procedure

All children were recruited and assessed at their school, and assessments were completed over a series of days by members of the research team. The full testing time was approximately 85 minutes per person. The undergraduates were recruited by advertising the study in their classes, and assessment sessions were completed on campus outside of scheduled lessons. All assessments were readministered 12 months later in the same manner.

Results

Who uses predictive text?

Table 1. Number of participants who self-reported using predictive text, by age.

Predictive text use	Primary school	Secondary school	University
Always	17	15	17
Sometimes	23	24	5
Never	43	38	26

As can be seen in Table 1, the majority of our sample did not use predictive texting at all, and many participants reported only sometimes using the feature. Based on T1 concurrent data, a chi-squared analysis was conducted looking at age group and selfreported predictive text usage; this was found to just fail to reach statistical significance; $\chi 2(4, N= 208) = 9.38, p = 0.052$. This shows that for our sample, there were no significant associations between predictive text usage and age group.

How does predictive text impact upon traditional textism use at Time 1?

Table 2. Time 1 mean textism ratios by predictive text use (with standard deviations in parentheses).

	Always	Sometimes	Never	Total
Shortenings	0.02 (0.05)	0.03 (0.08)	0.01 (0.03)	0.06
Contractions	0.05 (0.12)	0.05 (0.11)	0.03 (0.08)	0.13
G clippings	0.02 (0.06)	0.03 (0.09)	0.03 (0.06)	0.08
Other clippings	0.01 (0.01)	0.00 (0.01)	0.01 (0.02)	0.02
Symbols	0.05 (0.06)	0.04 (0.08)	0.04 (0.06)	0.13
Acronyms/initialisms	0.03 (0.04)	0.09 (0.12)	0.04 (0.06)	0.16
Letter/number homophones	0.12 (0.14)	0.10 (0.11)	0.10 (0.10)	0.32
Nonconventional spellings	0.04 (0.07)	0.04 (0.05)	0.05 (0.05)	0.13
Accent stylisation	0.04 (0.04)	0.04 (0.06)	0.05 (0.01)	0.13
Misspellings	0.02 (0.06)	0.02 (0.05)	0.03 (0.03)	0.07
Total	0.40	0.44	0.39	

Consistent with other studies in this area, we looked at textism use by combining all of Thurlow's (2003) traditional textism categories. We examined whether these textism ratios were different if predictive text was used 'always', 'sometimes' or 'never' in primary school and secondary school children, and we examined differences between 'always' and 'never' in university students because of the small sample size of 'sometimes'. A Kruskal–Wallis test was conducted on each age group because of the nonparametric distribution of the data. We found no significant differences between reported predictive text use and textism use in primary school, $H(2) = 4.87, p = 0.08$; secondary school, $H(2) = 0.37, p = 0.83$; or university groups, $U= 216.5, z =\_0.112, p = 0.91$.

Next, we looked at each individual category of traditional textisms (Table 2) to see if there were differences in usage based upon whether individuals used predictive messaging 'sometimes', 'always' and 'never' (again, 'sometimes' was omitted for university students). Kruskal–Wallis tests conducted on each age group showed no significant main effects of predictive text use on individual ratios of textism type at primary school, secondary school or university level. Thus, Hypothesis 1 was not supported; there was no difference in textism use regardless of predictive text usage.

Next, we looked specifically at the category of misspellings, to examine whether predictive text use was related to genuine spelling errors made in text messages. Misspellings were words that appeared to have been attempted correctly but were spelt wrongly, for example, wierd for weird. These spellings could not be categorised by any other traditional textism codes (e.g., accent stylisation and nonconventional spellings; see section on Test Battery). Kruskal–Wallis tests were conducted for each age group, comparing those who 'sometimes', 'always' and 'never' used predictive text (university students were compared just on 'always' and 'never'). No significant differences were found for university or primary school students. For secondary school students, there was a significant main effect of predictive text group on misspellings, $H(2) = 0.6$, $p = 0.046$. Bonferroni-corrected posthoc Mann–Whitney U tests were conducted, accepting a significance level of 0.017. Amongst those who never used predictive text, there were no misspellings ($M= 0.00$, $Mdn= 0$). When this mean ratio was compared with the mean ratio of misspellings in the other two groups, the difference did not reach corrected levels of significance, either for those who sometimes used predictive text ($M= 0.02$, $Mdn= 0$), $U= 363$, $z =\_2.307$, $p = 0.021$, or for those who always used predictive text ($M= 0.11$, $Mdn= 0$), $U= 248$ $z =\_2.189$, $p = 0.029$. These low medians are related to the low frequencies at which use of genuine misspelling was reported within the sample. When looking at the secondary students who made these errors ($N= 12$), the mean scores for those who always used predictive text were highest (1.75 instances of total words), followed by those who sometimes used predictive text (1.66) and finally those who never used predictive text (1.5). This trend shows that secondary students who use predictive text tended to make more misspelling errors than those who did not.

How does predictive text impact upon grammatical textisms at Time 1?

Table 3. Mean grammatical error ratios by predictive text use at Time 1 (with standard deviations in parentheses).

	Always	Sometimes	Never
Unconventional orthographic form	0.06 (0.07)	0.09 (17)	0.6 (0.08)
Punctuation and capitalisation error	0.22 (0.12)	0.27 (0.19)	0.28 (0.23)
Missing words	0.08 (0.08)	0.10 (0.15)	0.10 (0.10)
Grammatical homonyms error	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
Ungrammatical word form error	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)
Word reduction error	0.01 (0.03)	0.00 (0.01)	0.01 (0.02)

Time 1 self-reported predictive text-type and grammatical errors in text messages (grammatical textisms) were examined using (see Table 3 for mean grammatical error use). When looking at total grammatical textism ratios (combining all the errors listed in this section on Test Battery), we found no significant differences between those who used predictive text 'always', 'sometimes' and 'never' (omitting 'sometimes' for the university cohort), for either primary school, $H(2) = 1.35$, $p = 0.511$, or secondary school students, $H(2) = 0.08$, $p = 0.963$. University students, however, used significantly fewer total grammatical textisms in their text messaging when they used predictive text ($M= 0.22$, $Mdn= 0.18$), in comparison with those who did not use predictive text ($M= 0.27$, $Mdn= 0.25$), $U= 119$, $z =\_2.534$, $p = 0.011$.

To further examine grammatical textisms, we conducted Kruskal–Wallis tests to compare the predictive text groups on their use of specific grammatical violations in sent messages at T1. These violations were start-of-sentence emoticon use, using i in place of I, missing apostrophes (both contractive and possessive), missing words (pronouns, nouns, verbs and adverbs) and missing capitals (start-of-sentence capitals and proper noun capitals). For university students, there were no significant differences between users and nonusers of predictive text for any of the ratios of specific grammatical alterations. Secondary school participants differed in their use of grammatical textisms in four areas. The first was in relation to the use of start-of-sentence emoticons, H(2) = 8.38, p = 0.015. Post-hoc tests revealed no significant differences that met a Bonferroni-corrected level of significance. However, there was a trend for secondary school students who used predictive text (M= 0.003, Mdn= 0) to be more likely to use start-of-sentence emoticons than those who never used predictive text (M=0, Mdn= 0), U= 247, z =_2.272, p = 0.023. The mean ratios are once again small, showing that start-of-sentence emoticons are rarely used by either users or nonusers of predictive text. Significant differences between predictive texting groups were also found for use of the specific form of noncapitalisation i instead of pronoun I, H(2) = 7.90, p = 0.019. Post-hoc tests revealed that those who did not use predictive text (M= 0.01, Mdn= 0) were significantly more likely to use grammatical textisms of this type than those who only sometimes used predictive messaging (M= 0.002, Mdn= 0), U= 336, z =_2.708, p = 0.007. Further differences were seen between predictive text groups in terms of missing contractive apostrophes, H(2) = 6.13, p = 0.047. There were no significant post-hoc test results for this effect, but there was a tendency for those who used predictive text (M= 0.03, Mdn = 0.02) to be more likely to omit contractive apostrophes than those who did not use predictive text (M= 0.01, Mdn = 0) and those who only used it sometimes (M= 0.01, Mdn = 0). The final difference for secondary school participants was in their tendency to omit pronouns, H(2) = 6.48, p = 0.039. Post-hoc tests revealed that those who do not use predictive text (M= 0.04, Mdn = 0.03) made significantly more errors of this type than those who only sometimes used predictive text (M= 0.02, Mdn= 0), U= 291, z =_2.525, p = 0.012.

For primary school participants, only one significant main effect was observed, and this was in relation to missing capital letters when writing proper nouns, H(2) = 6.18, p = 0.045. Post-hoc tests revealed that those who used predictive text (M= 0.004, Mdn = 0) were significantly less likely to use this type of grammatical textism than those who did not use predictive text (M= 0.02, Mdn= 0), U= 240, z =_2.495, p = 0.013.

Does digital shifting occur?

Table 4. The number of participants in each predictive texting stability category, by age group.

	Stable users	Nonusers	Shifters	Partial shifters
University	10	17	13	7
Secondary school	6	27	10	24
Primary school	4	21	17	34
Total	20	65	40	65

Predictive texting habits were compared at T1 and T2. Textism stability was split into four main categories – stable users (those who always used predictive text at T1 and T2), nonusers (those who never used predictive text at either T1 or T2), shifters and partial shifters. Shifters were individuals who started the year either always using predictive text or never using it but by the end of the year had switched to the other category. Shifters were not further divided in terms of the direction of their shift, because the groups would have been too small for further analysis. Partial shifters were those who used predictive text 'sometimes' at T1 or T2 but at the other time point indicated that they 'always' or 'never' used predictive messaging. Again, this group was not split into smaller subgroups because it would have made the sample too small for further analysis. Finally, those who used predictive messaging 'sometimes' at both T1 and T2 were omitted from these analyses, as they were such a small group. The total number of participants in each group can be seen in Table 4.

A chi-squared test was conducted to look for any association between age group and texting stability group membership. A significant difference between predictive texting use at different ages was found, $\chi2(6, N= 190) = 18.93$, $p<0.005$. Looking at Table 4, we can conclude that primary school children were more likely to be partial shifters than either the secondary school children or the university students. As age group increases, there seems to be a move away from shifters and partial shifters, with university students more likely to be nonusers of predictive text than any other categories.

Does use of predictive text impact literacy and grammatical abilities?

Table 5. Mean growth in standardised measures between Time 1 and Time 2 (with standard deviations in parentheses).

	Primary school	Secondary school	University
WRAT spelling	0.01 (9.44)	1.5 (10.56)	3.1 (16.09)
Orthographic processing (word chains)	0.5 (16.91)	2.4 (13.31)	4.2 (9.68)
TROG II	4.8 (13.23)	2.6 (15.02)	4.9 (14.21)
Pseudoword orthographic choice	5.5 (11.14)	2.6 (13.26)	-9.6 (14.06)

Note: WRAT, Wide Range Achievement Test; TROG II, Test for Reception of Grammar II.

Growth was measured as an increase in the standardised scores between T1 and T2 (see Table 5 except for pseudoword orthographic choice, where raw scores were used, for this nonstandardised task). There were no significant main effects of predictive texting stability on growth in standardised spelling, orthographic processing or grammar (TROG II) scores, for any age group. These results therefore fail to support our hypothesis that the use of predictive text would affect standardised spelling scores.

However, there was a significant effect of predictive text group on the pseudoword orthographic choice task for university participants only, $H(3) = 11.78$, $p = 0.008$. Post-hoc Man–Whitney U tests showed that those who were stable users of predictive messaging showed a significant reduction in pseudoword orthographic choice over the year (M=_14.8, Mdn =_15) in comparison with those who did not use predictive text (M=0.41, Mdn=2), U= 30, z =_2.76, p = 0.006. Those who were shifters also showed a significant decrease in pseudoword orthographic choice scores when compared with stable users (M=_15.54, Mdn =_14.0), U= 43.5, z =_2.81, p = 0.005. From the mean scores shown in Table 6, we can see that for university students, predictive text has a negative association with performance on the pseudoword orthographic choice task over the course of a year.

Table 6. Mean raw scores for participants at Time 1 and Time 2 on the pseudoword orthographic choice task, split via predictive text category (with standard deviations in parentheses).

	University		Secondary school		Primary school	
	T1	T2	T1	T2	T1	T2
Stable users	59.5 (3.7)	43 (9.8)	38.6 (8.3)	41.1 (11.5)	34.4 (6.4)	43.4 (9.2)
Shifters	55 (7.5)	40.6 (12.4)	41.0 (9.8)	44.2 (10.4)	38.4 (6.0)	42.9 (10.0)
Nonusers	47.5 (9.9)	47.9 (11.3)	38.8 (7.2)	40.6 (8.3)	39.2 (6.9)	45.2 (10.7)

Note: T1, Time 1; T2, Time 2.

Keyboard and phone types

Table 7. Number of participants reporting their phone keyboard type, by predictive text usage.

	Use of predictive text		
	Always	Sometimes	Never
QWERTY	25	28	55
Alphabetic	8	4	15
Alphanumeric	15	19	35

Data on phone-type ownership were gathered from participants. At T1, the percentage of smartphone ownership was 50.6% for primary school students, 54.5% for secondary school students and 64.6% for university students. All these increased at T2 to 59%, 72.7% and 85.4%, respectively. This suggests that over time, the participants moved away from alphanumeric keypads, which in turn could reduce predictive text usage. We examined interactions at T1 between keyboard type and predictive text use via chi-squared analyses, which revealed no interactions for primary school, $\chi2(4, N=82)=1.14$, $p = 0.89$; secondary school, $\chi2(4, N= 74) = 5.01$, $p = 0.29$; or university cohorts, $\chi2(4, N= 48) = 2.66$, $p = 0.62$. Table 7, however, shows that most participants when using a QWERTY keyboard preferred not to use predictive text. It is important to note that although smartphones come with predictive text/autocorrect functions turned on, it is possible to switch them off.

Discussion

Despite previous studies suggesting that the use of predictive text may impact on individuals' use of texting slang (e.g., Drouin & Driver, 2012), we failed to find any evidence to support this in primary school, secondary school or undergraduate cohorts. For all age groups, those who used predictive text 'always', 'sometimes' and 'never' had similar levels of traditional textism use, failing to support our first hypothesis. However, it should be noted that our sample demonstrated relatively limited use of textisms in comparison with earlier studies, with a wider range in variance (e.g., Plester, et al., 2008). This change could be due to texting becoming cheaper in recent years and the increased use of QWERTY keyboards, reducing the need to use abbreviated forms. In accordance with our second hypothesis, university students who used predictive text made significantly fewer grammatical errors in their text messages than those who did not use it, perhaps because of the software correcting such mistakes for the user. However, university students' grammatical abilities (as assessed by the TROG II) were not significantly related to predictive text use. This suggests that differences for this age group in terms of grammatical textisms are not caused by individuals' underlying grammatical understanding.

Another ungrammatical feature of text messaging that is perhaps unintentional and possibly due to an overreliance on autocorrect features is the failure to capitalise the pronoun I. This is supported by the fact that secondary school students were less likely to use a capital I if they did not use predictive text. Secondary school-age predictive text users were also more likely to use start-of-sentence emoticons, which can be seen as indicative of choice and intention when texting. That is, people who use textisms in this way often do so in order to increase their feeling of social belonging (Thurlow, 2003) and to reinforce emotional awareness (Ganster, Eimler, & Krämer, 2012). Individuals who use predictive messaging may be more engaged with the technology and are thus experimenting with new linguistic forms, such as using emoticons to reinforce emotional understanding of the context of the message.

Secondary school students who sometimes used predictive text were less likely to miss out pronouns in their text messages in comparison with those who never used it. Predictive text will correct words, but it does not input missing words, and so this finding might reflect a reliance on predictive messaging to correct all errors. Also, writing with predictive messaging is faster than using multipress entry systems (Kemp & Bushnell, 2011), and so secondary school children may be trying to be quick but not checking their texts for missing words. It may also be that those individuals who are more conscientious about grammar when writing are also more likely to use predictive text within text messages to help to identify any other grammatical errors. They could therefore be actively looking for errors in their messages to correct and may be less likely to miss out words such as pronouns. Because of the way autocorrect works on many phones, contractive apostrophes are more likely to be automatically inputted, as opposed to possessive apostrophes. Contractive apostrophes are easier for predictive software to input as there is no ambiguity in their use (words that have missing letters always require an apostrophe, as in don't or I'm), whereas many words can occur in both possessive and plural forms, with the same spelling (e.g., cars and car's), and thus, possessive apostrophes are harder for phones to autocorrect than contractive apostrophes, as they depend upon the context of the sentence. Amongst secondary school students, we found that those who used predictive text were more likely to miss out contractive apostrophes than nonusers but no group differences existed for possessive apostrophes. We suggest that this is not due to ease of use but perhaps because so few possessive apostrophes are found in our sample of text messages (only two secondary school students used possessive apostrophes, whereas 25 used at least one contractive apostrophe). This difference could also reflect differences in predictive text programming. For instance, most phones either allow individuals to input their own words and build a dictionary or automatically 'learn' frequently used textisms or incorrect spellings. It is therefore possible that predictive text users at secondary school are more likely than the other age groups to use this function to experiment with language and grammar to make up their own sound-based spellings, which could explain why predictive users in this age group make more errors of this type.

Unfortunately, it would not be practical to look at all the programmed words in each participant's phone. However, future research may benefit from looking at different types of predictive text.

Our primary school cohort who never used predictive text used fewer capitals for proper nouns in comparison with predictive text users. This could suggest that those who do not use predictive text have not yet learned the correct use of capitals in terms of proper nouns. Most predictive text can input capitals when there is a specific grammatical rule to follow, such as at the start of a sentence or for well-known proper nouns. However, proper nouns for more obscure people and places are unlikely to be known by the software and thus not corrected. This overreliance could lead to primary school students in the future having trouble understanding the conventions about using capitals. However, our longitudinal data suggest that there are no effects of predictive texting on word-based or sentence-based grammar over the course of a year. This suggests that choice of text entry system may not affect literacy outcomes for primary school children.

It is prudent to note that ours is one of very few studies to use longitudinal data (Verheijen, 2013), meaning that cause and effect can be more easily determined using our sample and, for the first time, stability of texting features can be examined. Predictive text use was not a stable feature over the course of a year for any age group, meaning that 'digital shifting' is occurring. This could be due to reasons such as acquiring a new phone with new features or a new keyboard, so their preference towards,predictive messaging may have changed to adapt to the phone. However, acquiring a new phone may not be the main reason individuals change in behaviour, as keyboard type seems to have little to do with predictive text usage. It is possible then that individuals simply choose to switch their style of messaging because they want to experiment with new writing styles. With new technology being released so frequently, this makes the 'shifting' group a very interesting one to study in order to assess how digital code-switching is impacting upon language. Shifters and partial shifters made up just over half of the participants of the current study. Shifting became less apparent in the older cohorts but was still present. The current study found significant differences only between shifters and nonshifters in terms of adults' morphological awareness, with shifters acting more like those who use predictive text than like those who do not. However, the current study did not have enough participants to break down the shifters into smaller subgroups (those who moved towards using predictive text and those who moved away from it were grouped together). The surprisingly high number of individuals choosing to use predictive messaging only 'sometimes' suggests that this change is more a reflection of personal choice and that 'digital shifting' is happening more frequently than we originally proposed. Potentially, similar to Conti-Ramsden et al.'s (2011) study, the variability in usage could be due to the predictive texting software not being able to correctly predict words in all circumstances, especially for those who have greater language problems. Predictive text features still need to be studied in greater detail across a variety of abilities, in order to understand this in more detail and its impact upon literacy.

Problems arise from the large number of 'sometimes' users as the sample of texts received from the participants was a 'snapshot' from a 2-day period. Thus, if users report using predictive text only sometimes, we cannot know for sure whether the messages we acquired were written with predictive messaging. It is possible that some users turn predictive text on and off over the course of a few days or even within the space of writing one message. Further research is required to examine the group who use predictive messaging only sometimes, as there is potential for great variation within this subgroup. It is also possible that individuals feel that it is appropriate to change their style of writing according to the receiver of the message (as was observed by Grace et al., 2013). If predictive messaging removes textisms that allude to belonging to the social group being texted (Thurlow, 2003), then individuals may choose to turn off predictive text whilst contacting that particular social group. Similarly, if individuals are texting either someone who may not understand their textisms (such as an older relative) or someone in a more formal manner (such as a work colleague), then they may prefer to leave predictive text turned on to quickly correct any errors in their message. However, participants were not asked to define their own personal understanding of the terminology 'predictive text'. Some participants may have seen autocorrect features as not being predictive text and assumed predictive text only included traditional T9 multipress entry method. Other participants may have included autocorrect features in their own personal definitions of predictive text. Similar autocorrect features are present in other technological formats such as tablet use, some web browsers and even word processing software. Thus, it will be important for future research to contrast the differences between autocorrect features in different formats such as these.

The reason that different age cohorts may be affected differently by predictive text usage may reflect different levels in their grammatical awareness (Pacton & Deacon, 2008). Primary school children still have the most to learn grammatically, both in terms of punctuation and word-based grammar (such as morphology and syntax), and they may make their errors because of a lack of understanding (Pacton & Deacon, 2008). Secondary school children can still benefit from learning explicit grammatical rules at school (Myhill, Jones, Lines, & Watson, 2012) as they have not yet fully developed their understanding of grammar. Using predictive text 'sometimes' allows secondary school children both to be exposed to standard grammar and to have the opportunity to learn through their own experimentation when they do not use predictive text. Cingel and Sundar (2012) found evidence of negative links for secondary school-age children between self-reported textism use and grammatical abilities. Our current study contradicts this by failing to find evidence of negative effects on standardised measures of spelling, grammar or orthography because of predictive texting. Therefore, we believe that writing in an untraditional grammatical way within a text message may be a reflection of secondary school children experimenting with writing, rather than them not being able to write in a conventionally grammatical style. Undergraduates have arguably already acquired grammatical knowledge and therefore may be either producing grammatical violations in their text messages because they choose to (as they already know the correct grammatical structure) or because texting is directly affecting their grammatical knowledge. It is unlikely that sentence-level grammar is being affected negatively, as we found that predictive text usage was not associated with grammatical awareness on the TROG II. For university students, however, those who were stable users of predictive messaging performed significantly less well over time on the pseudoword orthographic task than stable nonusers. This suggests that for the university cohort, use of predictive text appears to be associated with lower levels of morphological knowledge. It may be that university students who use predictive text are not explicitly thinking about the morphology of words, and thus, morphological representations are not being strengthened cognitively. This contrasts with younger children who are still in the process of acquiring their understanding of word structure and therefore are more likely to be reflecting on the nature of morphological representation as part of their English studies at school. University students who are stable in using predictive text across a whole year, however, show less decline than shifters. This may be because adults are not as good at switching between different language formats as children (Hernandez & Kohnert, 1999) or are not yet used to the technology they have switched to. These findings have significant implications, given that smartphone ownership and the use of predictive text/autocorrect features are high with all age groups, 27% of primary aged children, 67% of secondary aged children and 65% of adults (Ofcom, 2014).

More university students could be degrading their morphological awareness, which could impact upon university work, job applications and future careers. For this reason, it is imperative that we look more closely at this cohort to determine how we can mitigate against apparent suppression of morphological understanding. The main limitation of the current study is that we are unable to identify whether participants made grammatical errors deliberately or by accident. If they made errors deliberately, then it is likely that they still understand grammatical rules but chose not to use them to save on time or because it is fun to violate the rules of conventional writing. Kemp, Wood and Waldron (2014) showed that primary school, secondary school and adult participants have an awareness of the language they use in different contexts. When asked to correct grammatical errors in text message examples, they could all correct approximately half of those errors. This suggests that the majority of the grammatical violations seen in the messages in the current study may well have been deliberate. Such an interpretation is borne out by the results of recent work conducted by

Kemp and Clayton (in press), who found through experimental work that undergraduate students were sensitive when to use textspeak and could vary their style of written communication in line with who was likely to read it. However, there is still room for further research to look at the extent of deliberate versus accidental grammatical errors in texting.

Conclusions

The use of predictive text was neither stable nor consistent for any age group at the time when this study was conducted. We recognise that at the time when this study was conducted, it was easier to turn predictive text on and off, whereas at the time of publication, the type of devices owned by individuals now includes autocorrect functions, which are more difficult to disable. It is exactly because of the increased implementation of predictive text and autocorrect functions on contemporary mobile devices, which include not just phones but tablets and similar technology that the findings from this study have salience today. At a time when it was possible to manipulate this function more easily, we found that predictive text use did not impact upon textism use at any age but secondary school children who used predictive text were more likely to make genuine spelling errors in their texts. Adults who used predictive text used fewer total grammatical violations when texting. Secondary school students who used predictive messaging were less likely to omit pronouns and less likely to use ‘i’. Primary school students who used predictive messaging were more likely to capitalise proper nouns. However, perhaps most significantly, predictive texting had a negative impact on morphological grammatical abilities for adults who use predictive text. More work is needed to examine the long-term impact of predictive text functions of frequently used digital devices on adults to see if the findings observed in this study can be replicated and, if so, what can be performed to counter the impact of such use on morphological understanding.

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